Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB04/005118

International filing date: 06 December 2004 (06.12.2004)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0328292.8
Filing date: 05 December 2003 (05.12.2003)

Date of receipt at the International Bureau: 01 April 2005 (01.04.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

PCT/GB 2004 / 0 0 5 1 1 8

21 MARCH 2005

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 9 December 2004

Patents Form 1/77

Patents Act 1977
(Rule 16)

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference — MJD/64086/000

0328292.8

2. Patent application number
(The Patent Office will fill this part in)

05 DEC 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

MicroGen Energy Limited
100 Thames Valley Park Drive
Reading
Berkshire, RG6 1PT
United Kingdom

Patents ADP number *(if you know it)*

8476314001

If the applicant is a corporate body, give the country/state of its incorporation — GB

4. Title of the invention — A Stirling Engine Assembly

5. Name of your agent *(if you have one)*

BOULT WADE TENNANT

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

VERULAM GARDENS
70 GRAY'S INN ROAD
LONDON
WC1X 8BT

Patents ADP number *(if you know it)* — 42001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

YES

Answer YES if:

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.

Otherwise answer NO (See note d)

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	7
Claim *(s)*	2
Abstract	-
Drawing *(s)*	4

+45N

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature — Date

5 DECEMBER 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Martyn J. Draper

020-7430-7500

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

A STIRLING ENGINE ASSEMBLY

The present invention relates to a Stirling engine assembly.

Stirling engines are known which have a Stirling engine burner surrounding a heater head, which may be provided with heat transfer fins. For certain applications, it is desirable to monitor the metal temperature of the head in order to ensure that it is maintained at a safe level so that material degradation does not occur. Excessive metal temperatures accelerate oxidation of the metal and, in the case of a Stirling engine having brazed fins, will tend to degrade the braze fixing the fins to the head. This degradation will reduce the effectiveness of the heat transfer from the burner gases to the Stirling engine with a resultant reduction in engine efficiency. In addition, under normal operation, the temperature of the surface of the heater head is directly related to the quantity of heat transferred into the gas within the heater head, which is in turn related to the generated power output. The heater head metal temperature can therefore be used as an engine control parameter. For this to be possible an accurate measurement of the metal temperature is required.

Due to the hostile environment within the burner region, the expected life of a low-cost temperature sensor is limited (anticipated to be around three years). A sensor designed to survive the lifetime of the engine/burner assembly (around ten years) without replacement will therefore need to be of a higher reliability, high cost

design. Such a sensor is prohibitably expensive for a Domestic Combined Heat and Power (DCHP) system.

The heated head of the Stirling engine is fully enclosed by the burner assembly which will generally include an associated recuperator. This assembly must remain sealed to prevent leakage of harmful combustion gases into the appliance so that access to this region is not possible.

The invention aims to provide a low cost solution to the problem of measuring the temperature of a Stirling engine head.

According to the present invention a Stirling engine assembly comprises a Stirling engine having a head, an annular burner surrounding the head and defining a combustion chamber between the burner and head, an annular seal between the burner and head to provide a seal for combustion gases, a thermocouple housing in thermal contact with the head and sealed from the combustion chamber, the thermocouple housing extending out of the combustion chamber, with the interface between the thermocouple and combustion chamber being sealed, the thermocouple housing having an opening outside the combustion chamber, and a thermocouple in the thermocouple housing extending from a location adjacent to the head out of the opening in the thermocouple housing.

Providing a thermocouple housing which is sealed to the combustion chamber, and open outside of the combustion chamber allows easy access to the thermocouple housing

allowing simple replacement of the thermocouple during routine maintenance.

Preferably, the Stirling engine has a plurality of fins surrounding the head. In this case, at least one fin is preferably provided with an orifice to allow the thermocouple housing to pass therethrough. Preferably, this orifice is located adjacent to the engine head, such that the housing passes through the at least one fin adjacent to the head.

Preferably, the opening in the thermocouple housing is sealed by a cap through which the thermocouple extends. This serves to support the thermocouple in the correct place within its housing, and prevent any inadvertent leakage of combustion gases through the joint of the thermocouple housing and the flanged sheath escaping through the cap.

An example of a Stirling engine assembly in accordance with the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a cross-section through the right hand side of a Stirling engine head;

Fig. 1a shows in greater detail the design of region "b" in Fig. 1.

Fig. 2 is a cross-section similar to Fig. 1 of a second example of a Stirling engine; and

Fig. 3 is a schematic perspective view of the second example.

In most respects, the Stirling engine is known in the art, for example from PCT/GB03/00208. The engine comprises a head 1 with a plurality of internal fins 2 surrounding the inner surface of the head, and a plurality annular fins 3 surrounding the exterior of the head. These fins have a generally truncated frustoconical configuration and are arranged along the main axis of the head. The fins are surrounded by an annular burner 4. Gases to the burner are supplied along combustion gas inlet path 5 so that the exhaust gases pass around the top of the head 1 and pass out through exhaust duct 6. Beneath the fins 3 and burner 4 is an annular seal assembly 7 which is provided to prevent the escape of combustion gases into the atmosphere. The seal assembly forms the subject of our earlier application PCT/GB03/00208. A block of insulation 8 is situated generally in between the burner 4 and seal 7 to insulate the seal 7 from the hot combustion gases in the combustion chamber.

A thermocouple housing 10 made of stainless steel and having a closed upper end extends from a location abutting the engine head 1 just below the uppermost fin 3 down through all of the remaining fins, and then downwardly and outwardly away from the engine through the insulation 8. The thermocouple housing 10 is held in place by a flanged sheath 12 which is bolted to an engine sealing plate 13 via a plurality of bolts 14 (only one of which is shown in Fig. 1) and extends into the insulation 8. This interface is sealed by a gasket 15.

The lower end of the thermocouple housing is sealed by a sealing cap 16 which is a bayonet fit, but could also be a screw fit, onto the flanged sheath 12. The interface between the thermocouple housing 10 and cap 16 is sealed by a second gasket 17.

A thermocouple element 18 extends all the way along the thermocouple housing from the end which is in thermal contact with the head out through the cap 16. A plug 19 is provided to interface with a control system (not shown).

In practice, a second such thermocouple housing will be provided close to the first housing as two independent sensors (for overheat and control) are required.

In order to assemble the device, the two thermocouple housings 10 are brazed in place. Each of the heat transfer fins 3 (with the exception of the top fin) is provided with a cut-out portion to accommodate the thermocouple housing 10. The fins are, for example, stainless steel, inconel, or aluminium bronze. These are placed over the head 1 and brazed in place. This can be carried out by either "wetting" the inner surface of the fins with a braze compound, or coating with a slurry using an airgun before installation. Alternatively, a pre-formed "washer" of brazing compound is installed between the fin and the heating head. Upon heating to a temperature suited to the specific braze compound, a uniform brazed joint is formed with optimal heat transfer properties.

Alternatively, the thermocouple housing 10 and fins 3 can be brazed in a single operation. This operation may also include brazing the internal copper fins 2. In order to do this, the components have to be put together in an assembly jig to ensure correct alignment before heating the components to the required temperature thereby forming all of the joints in a single process.

Once the burner 4 is located around the heater head, the asymmetrically flanged guide sheath 12 is pushed through an opening in the engine plate 13 and insulation 8. This sheath is then bolted in place as shown. A thermocouple 18 is then pushed up into the housing 10 to a position shown in Fig. 1. The sealing cap 16 is then put into place and sealed.

An alternative design is shown in Figs. 2 and 3 in which similar components have been designated with the same reference numbers. Fig. 3 shows the two thermocouple housings 10 referred to in respect of Fig. 1, but not illustrated.

Rather than extending axially down the heater head 1, the upper thermocouple element 10A in Fig. 3 extends obliquely away from the head, thereby passing through the fins 3. Thus, the fins 3 may either be provided with offset cut-outs to accommodate this, or may be provided with cut-outs which extend across their full radius effectively forming an open ring. The second thermocouple housing 10B only extends to a location beneath the lowermost fin 3.

When a thermocouple failure is detected, or a service replacement is required, the sensor plug 19 is disconnected, the sealing cap 16 is removed and the thermocouple element 18 is pulled out of the housing 10. A replacement element is then fitted, the sealing cap 19 is replaced and the sensor plug 19 is reconnected.

CLAIMS

1. A Stirling engine assembly comprising a Stirling engine having a head, an annular burner surrounding the head and defining a combustion chamber between the burner and head, an annular seal between the burner and head to provide a seal for combustion gases, a thermocouple housing in thermal contact with the head and sealed from the combustion chamber, the thermocouple housing extending out of the combustion chamber, with the interface between the thermocouple and combustion chamber being sealed, the thermocouple housing having an opening outside the combustion chamber, and a thermocouple in the thermocouple housing extending from a location adjacent to the head out of the opening in the thermocouple housing.

2. A Stirling engine assembly according to claim 1, wherein the Stirling engine has a plurality of fins surrounding the head.

3. A Stirling engine assembly according to claim 2, wherein at least one fin is provided with an orifice to allow the thermocouple housing to pass therethrough.

4. A Stirling engine assembly according to claim 3, wherein the orifice is located adjacent to the engine head, such that the housing passes through the at least one fin adjacent to the head.

5. A Stirling engine assembly according to any one of the preceding claims, wherein the opening in the thermocouple

housing is sealed by a cap through which the thermocouple extends.

Fig 1a

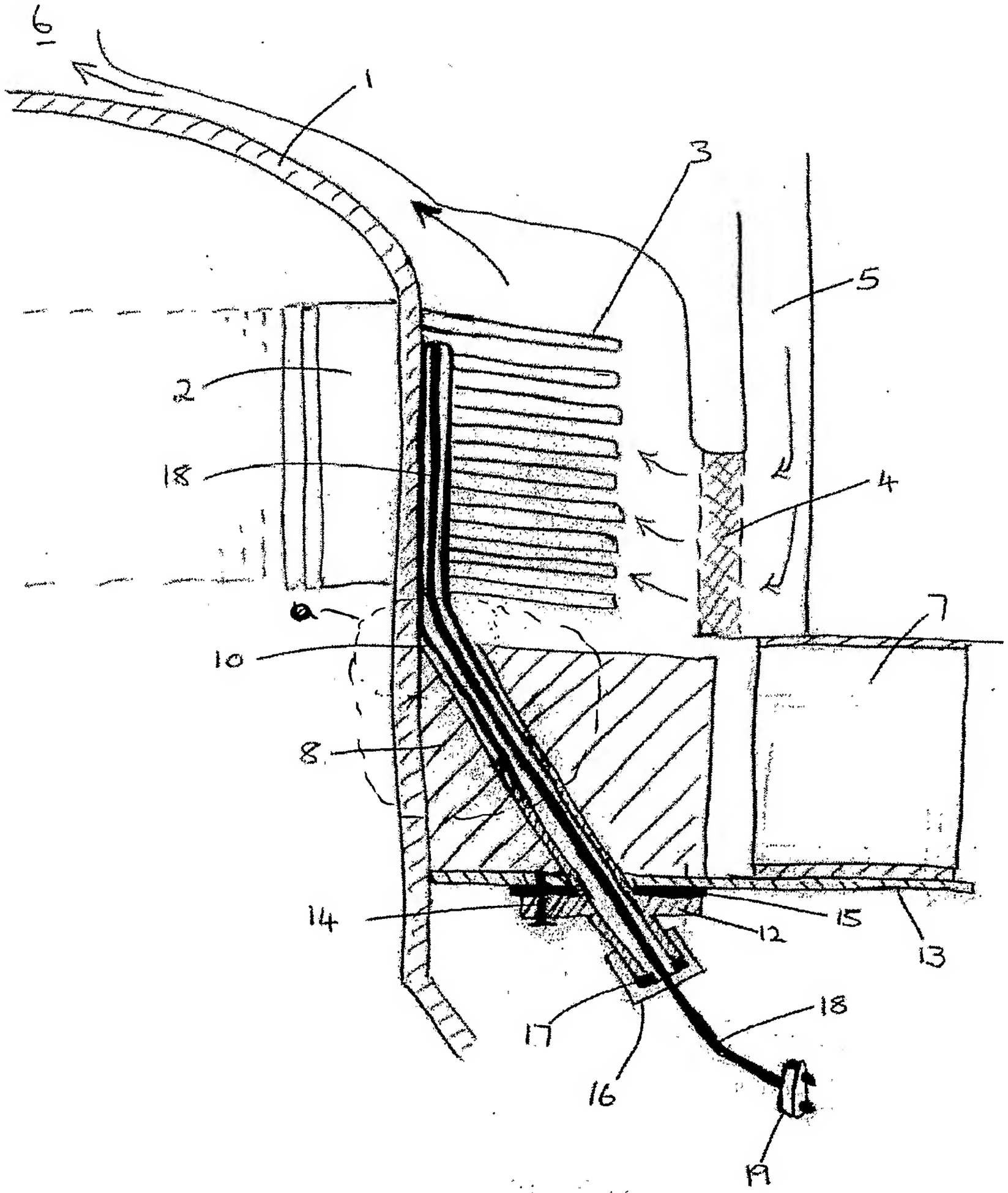

Fig 1b

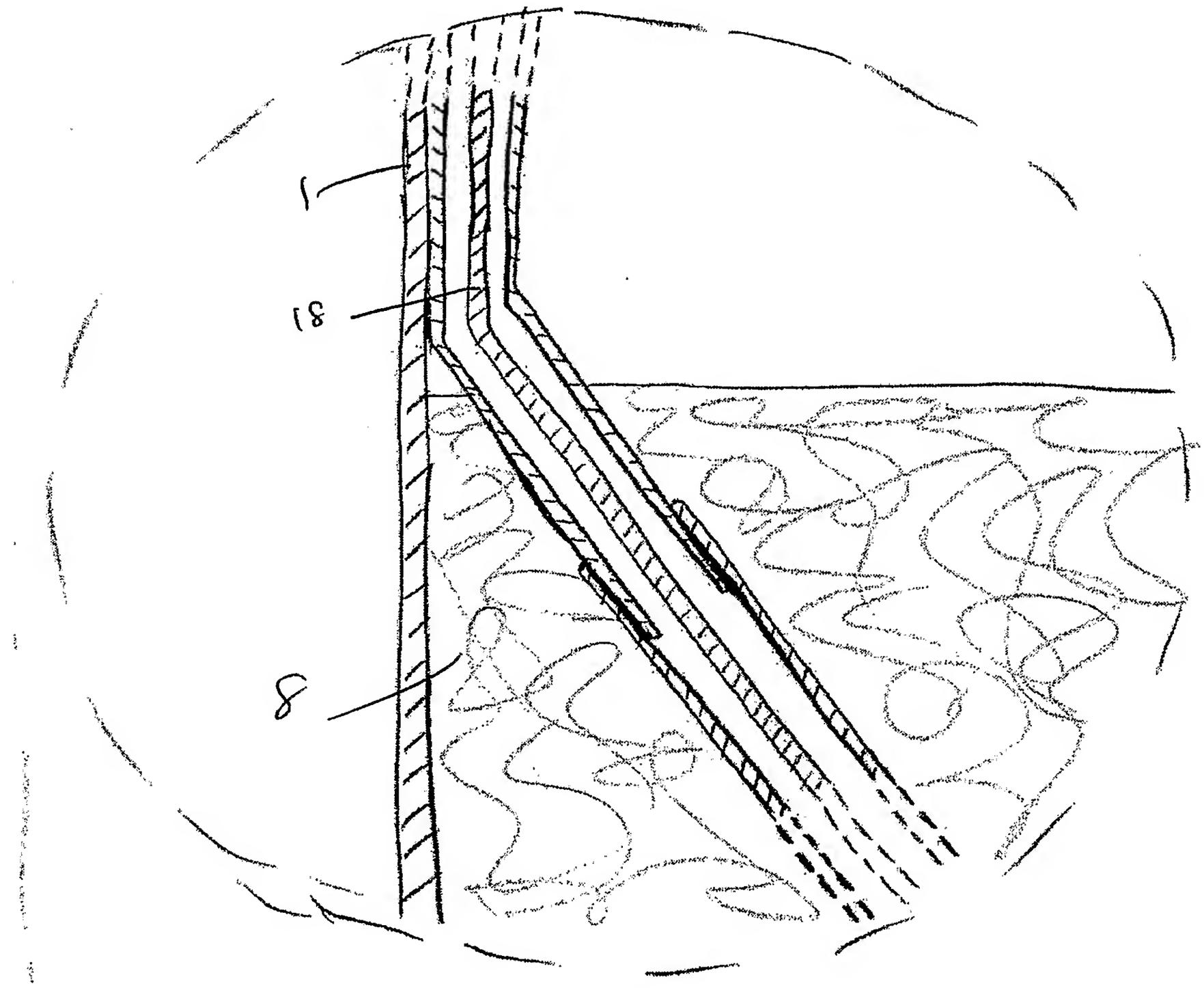

Fig 2

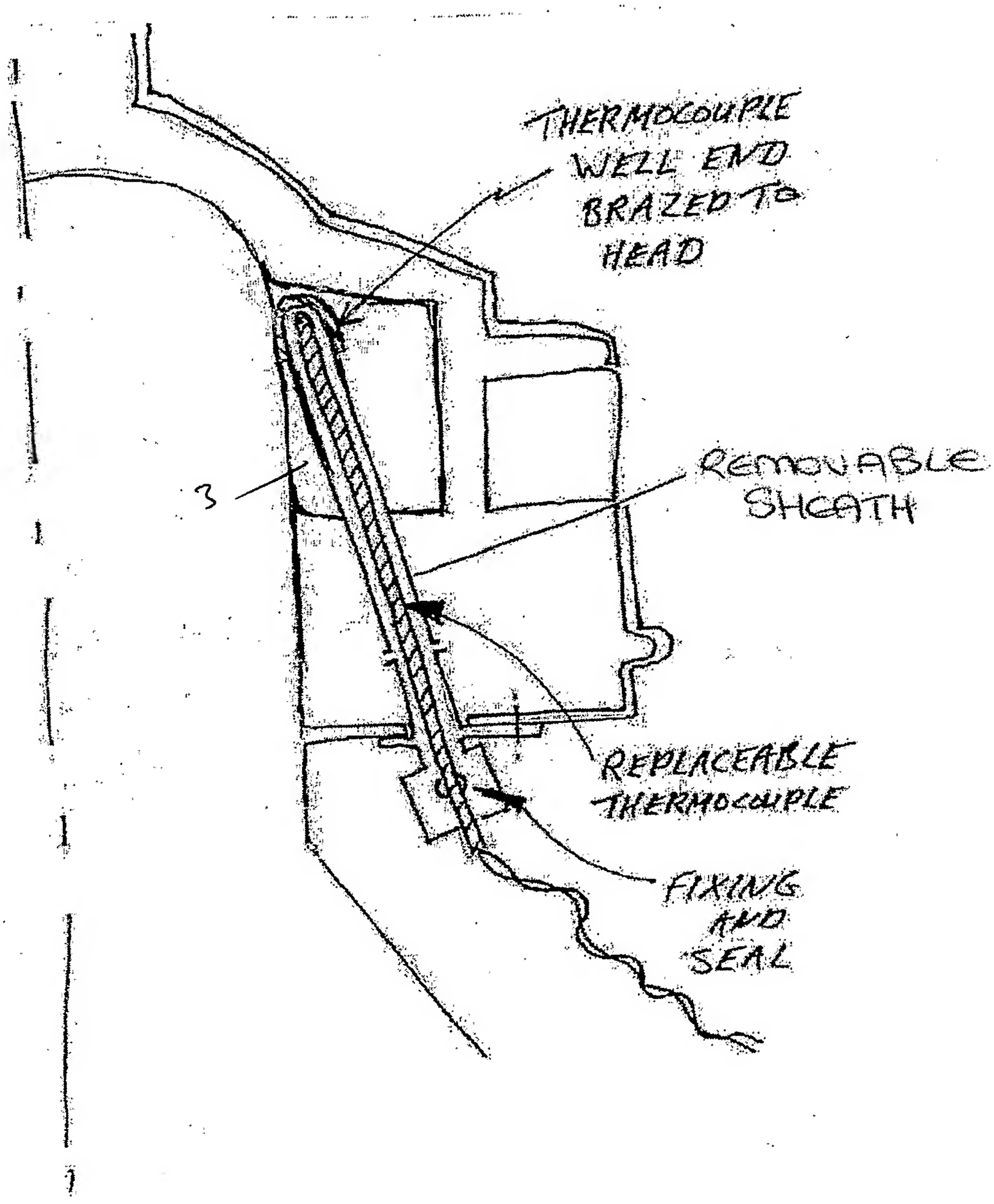
THERMOCOUPLE WELL END BRAZED TO HEAD
3
REMOVABLE SHEATH
REPLACEABLE THERMOCOUPLE
FIXING AND SEAL

Fig 3